IS 8644 (2001): Strip-Wound Cut Cores of Grain Oriented Silicon-Iron Alloy, Used for Electronic and Telecommunication Equipment [LITD 5: Semiconductor and Other Electronic Components and Devices]

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IEC 329 (1985)
(Reaffirmed 2004)

भारतीय मानक

इलैक्ट्रॉनिकी और दूरसंचार उपस्कर में प्रयुक्त कण उन्मुखी सिलिकान-लौह मिश्रधातु की पट्टिका-कुन्डलित कट कोर

(पहला पुनरीक्षण)

Indian Standard

STRIP-WOUND CUT CORES OF GRAIN ORIENTED SILICON-IRON ALLOY, USED FOR ELECTRONIC AND TELECOMMUNICATION EQUIPMENT

(First Revision)

ICS 29.100.10; 29.180

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August 2001 **Price Group 14**

NATIONAL FOREWORD

This Indian Standard (First Revision) which is identical with IEC 329 (1985) 'Strip-wound cut cores of grain oriented silicon-iron alloy, used for electronic and telecommunication equipment' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of Magnetic Components and Ferrite Materials Sectional Committee and approval of the Electronics and Telecommunication Division Council.

This standard establishes a uniform code for the operating temperature range, the mechanical and electrical properties, the marking and packaging and the measuring methods for strip-wound cut cores of grain oriented silicon-iron alloy. This standard also includes ranges of preferred sizes of cores.

This standard has been revised to modify the ranges of preferred sizes of cores and to align it with the latest international practices.

The text of the IEC has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

CROSS REFERENCES

In the adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 68-1(1982) Environmental testing—Part 1: General and guidance Amendment 1 (1992)	a) IS 9000 (Part 1) : 1988 Basic environmental testing procedures for electronic and electrical items: Part 1 General b) IS 9001 (Part 1) : 1984 Guidance for environmental testing: Part 1 General	Technically Equivalent
IEC 68-2-14 (1984) Environmental testing—Part 2: Tests—Test N: Change of temperature	IS 9000 (Part 14/Sec 1 to 3) : 1988 Basic environmental testing procedures for electronic and electrical items: Part 14 Change of temperature	do

The concerned Technical Committee responsible for the preparation of this standard has reviewed the provisions of the following International Publications and has decided that they are acceptable for use in conjunction with this standard:

IEC 50 (05)	International Electrotechnical Vocabulary (IEV), Group 05: Fundamental definitions [since withdrawn and replaced by IEC 60050 - 111 (1996)]
IEC 68-2-1(1974)	Environmental testing — Part 2: Tests — Test A: Cold [since revised in 1990]

Only the English language text of the International Standard has been retained while adopting it in this Indian Standard.

Indian Standard

STRIP-WOUND CUT CORES OF GRAIN ORIENTED SILICON-IRON ALLOY, USED FOR ELECTRONIC AND TELECOMMUNICATION EQUIPMENT

(First Revision)

SECTION ONE - GENERAL

1. Scope

This standard is limited to strip-wound cut cores, in both single-phase and three-phase forms of construction, having rectangular cross-sections and rectangular windows (coil spaces), manufactured from cold-reduced grain-oriented silicon-iron alloy strip, and for use in transformers and inductors for telecommunication equipment and for electronic devices.

This standard may be generally applied to cores of other than rectangular window or cross-section. In this case, certain characteristics, e.g. electrical properties and dimensional tolerances shall be the subject of special agreement between user and manufacturer.

2. Object

To establish a uniform code of practice for:

a) the operating temperature range;
b) the mechanical and electrical properties;
c) the marking and packaging;
d) the measuring methods.

This standard also includes ranges of preferred sizes of cores.

3. Terms and definitions

3.1 *General terms*

For the definitions of the general terms used in this standard, reference should be made to IEC Publication 50(05): International Electrotechnical Vocabulary, Group 05: Fundamental Definitions. For the purpose of this standard, the following definitions shall apply.

3.2 *Strip-wound cut core*

Core manufactured from a continuous strip of the specified material wound on a mandrel to form a core loop. After stress-relief annealing and then impregnating with a suitable bonding agent to ensure adequate inter-lamination adhesion, this core loop is cut into two parts.

Note. - To obtain the required total length of strip, it is permissible to weld two shorter lengths together.

3.3 *C-core loop (C-core)*

Single-phase strip-wound cut core.

Note. - The term C-core is in common and international use. To avoid confusion it must be emphasized that one C-core consists of two C-shaped parts. A preferable term is C-core loop.

3.4 *E-core loop (E-core)*

A three-phase type of strip-wound cut core consisting of two single-phase loops placed side by side and a third loop, having the same build-up and strip width as these, being wound around them. The resulting assembly has, therefore, three limbs of equal cross-section and two equal windows or coil spaces.

Note. – The term E-core is in common and international use. To avoid confusion it must be emphasized that one E-core consists of two E-shaped parts. A preferable term is E-core loop.

3.5 *Nominal gap length*

A value for the summated axial magnetic lengths of the gaps, given in order that the apparent power expended in those gaps may be calculated.

Notes 1. – The gap length is not subjected to dimensional check.

2. – It is common practice to use the term "gap" in the singular although the single-phase cut core loop possesses two actual gaps and the three-phase cut core loop possesses three actual gaps.

3. – In practice, the leakage flux with the nominal gap is neglected.

3.6 *Specific power loss*

The loss per unit mass of the core in W/kg (W/lb), occurring when the flux density produced by an alternating field is sinusoidal. The symbol adopted is P_{Ls}.

3.7 *Specific total reactive power*

The total reactive power per unit mass of the core in var/kg (var/lb), occurring when the flux density produced by an alternating field is sinusoidal. It is the arithmetic sum of the specific reactive power for the iron path (Q_{Fs}) and the specific reactive power for the gap (Q_{Gs}). The symbol adopted is Q_s, thus:

$$Q_s = Q_{Fs} + Q_{Gs}$$

3.8 *Specific total apparent power*

The total apparent power loss per unit mass of the core in VA/kg (VA/lb), occurring when the flux density produced by an alternating field is sinusoidal. It is the product of the r.m.s. voltage and the r.m.s. current, divided by the core mass. It is also the vector addition of the specific power loss P_{Ls} and the specific total reactive power Q_s. The symbol adopted is S_s, thus:

$$S_s = \sqrt{P_{Ls}^2 + Q_s^2}$$

3.9 *Space factor*

The ratio of the effective iron cross-sectional area of the core to its geometrical area, this latter being the product of the build-up and the strip width. The symbol adopted is α.

4. Construction

4.1 *Material*

A cold-reduced grain-oriented silicon-iron alloy in continuous strip form, insulated on one or both sides. Table I gives the material thicknesses available and the frequencies commonly associated with these.

TABLE I

Nominal strip thickness (mm)	Nominal strip thickness (in)	Frequency (Hz)
0.28 ... 0.35	0.011 ... 0.014	50 and 60
0.10	0.004	400
0.05 0.025	0.002 0.001	Above 2 000 and pulse applications

4.2 *Gap*

A core loop is cut along a plane perpendicular to the major axis (dimension *B*, see Tables VI and VII, pages 19 and 24) and to the direction of the strip winding.

Notes 1. - In smaller cores, this cutting plane is centrally placed in relation to the larger window dimension. In larger cores, it may be displaced from this central location with respect to the larger window dimension.

2. - The required flatness of the gap faces is mainly determined by the electrical performance.

4.3 *General appearance and condition*

Cores shall be supplied in a generally clean condition, free from rust and from magnetic dust. There shall be a minimum amount of bonding agent on core external surfaces but the individual laminations shall be firmly bonded together and the cores shall be free from splits.

Note. - A gap surface may exhibit "hair-line" cracks but provided no delamination occurs it shall be considered free from splits.

4.4 *Dimensions*

4.4.1 *Dimensional specifications*

The dimensions and their tolerances are specified in Section Four of this publication.

Note. - Where in these tables both millimetre and inch dimensions are given, the conversion has not been made by applying recommended conversion rules. The dimensions in the non-original units have been added for information and need not be related to existing types.

4.4.2 *Standard tolerancing system*

See Appendix C.

4.5 *Marking*

Each core loop shall be marked to ensure easy identification and to enable users to correctly assemble the two halves together.

If the core loops are too small for legible marking to be made on the cores themselves, the package marking given in Clause 5 shall be deemed sufficient. The core halves shall then bear a marking indicating correct assembly.

The identification marks shall be:

a) the manufacturer's name, trade mark or other symbol;

b) the strip thickness code letter; or

c) the type reference number when requested by the purchaser.

Notes 1. – In the first column of Tables VI to XI, pages 19 to 39, the type reference numbers of the cores are given. To complete the core reference number it is necessary to add a code letter for the nominal strip thickness, viz.:

W for 0.28 mm and 0.35 mm strips
X for 0.10 mm strips
Y for 0.05 mm strips
Z for 0.025 mm strips.

Example:

A core of the Series Q with the overall dimensions $A_{max} \times B_{max}$ = 49.6 mm × 92.1 mm, wound from a strip with width D_{min} = 38.1 mm and thickness 0.28 mm, will bear the reference number Q 8.3 W. This same method is used for three-phase cores.

2. – One suggested method of ensuring correct assembly of the two core halves is the marking of a serial number on each of the two halves in such a position that the two serial numbers are side by side when the core is assembled correctly. This method is also recommended because it prevents assembling of two unrelated core halves.

5. Packaging

Each loop shall be so packed that adequate protection is given to the gap faces to prevent mechanical damage. The gap faces shall also be protected from rusting by the application of a suitable grease or by some alternative method. The container used shall have a suitable label giving:

a) the manufacturer's name; the trade mark or other symbol alone is not acceptable;

b) the core reference number (see Sub-clause 4.5);

c) the operating temperature range;

d) the number of core loops it contains.

Note. – Collective packaging may be employed only for cores of the same core reference number.

6. Operating temperature ranges

Cores to this standard shall be suitable for continuous use over one of the temperature ranges according to Table II. This temperature range shall also apply to the storage of these cores. Alternative temperature ranges may be agreed between user and manufacturer.

TABLE II

Code	Temperature range
40/125	−40 °C to +125 °C
55/155	−55 °C to +155 °C

SECTION TWO – ELECTRICAL PERFORMANCE

7. Basic values

7.1 *General*

The electrical performance of a strip-wound cut core shall be indicated by the maximum permissible power loss and apparent power loss at a specified frequency and flux density.

These permissible losses shall be calculated from the specific values given in Table III for C-cores and in Table IV, page 6, for E-cores.

It must be emphasized that the specific values of the reactive power for the iron and for the air gap, Q_{Fs} and Q_{Gs} respectively, are given solely for the purpose of calculating the total reactive power for any size of core, such calculation being necessary for the determination of total apparent power S.

7.2 *Specific electrical characteristics of C-core loops*

TABLE IIIA
(Metric system)

Nominal strip thickness	Frequency f	Nominal peak flux density B	Specific power loss P_{Ls}	Specific reactive power for the iron Q_{Fs}	Specific reactive power for the air gap Q_{Gs} 1)
mm	Hz	T	W/kg	var/kg	var/kg
0.28 ... 0.35	50	1.7	2.2	13	$\frac{141.5}{l_{Fl}}$ 2)
0.28 ... 0.35	60	1.5	2.0	3.7	$\frac{132}{l_{Fl}}$ 2)
0.10	400	1.5	22.0	25	$\frac{881}{l_{Fl}}$ 2)
0.05 0.025	Performance levels to be agreed between user and manufacturer				

TABLE IIIB
(Inch-pound system)

in	Hz	T	W/lb	var/lb	var/lb
0.011 ... 0.014	50	1.7	1.0	5.895	$\frac{25.26}{l_{Fl}}$ 3)
0.011 ... 0.014	60	1.5	0.9	1.70	$\frac{23.5}{l_{Fl}}$ 3)
0.004	400	1.5	10	11.34	$\frac{157.3}{l_{Fl}}$ 3)
0.002 0.001	Performance levels to be agreed between user and manufacturer				

1) These values are based on a nominal gap length of 30 μm (0.0012 in). Other values for Q_{Gs} are to be subject to special agreement between user and manufacturer. Q_{Gs} is proportional to frequency, to flux density squared and to gap length.

2) In Table IIIA, the mean flux path length concerned (l_{Fl}) is in centimetres and is calculated as shown in Clause 8. The values for Q_{Gs} have been calculated on the assumption that the flux density in the air gap is the same as in the iron.

3) l_{Fl} in inches.

7.3 *Specific electrical characteristics of E-core loops*

TABLE IVA
(Metric system)

Nominal strip thickness	Frequency f	Nominal peak flux density $\hat{B}$	Specific power loss P_{Ls}	Specific reactive power for the iron Q_{Fs}	Specific reactive power for the air gap Q_{Gs} 1)
mm	Hz	T	W/kg	var/kg	var/kg
0.28 ... 0.35	50	1.5	2.1	5.3	$\frac{1.27\,A_{Fe}}{m_{Fe}}$ 2)
0.28 ... 0.35	60	1.5	2.4	5.4	$\frac{1.52\,A_{Fe}}{m_{Fe}}$ 2)
0.10	400	1.3	20	25.0	$\frac{7.6\,A_{Fe}}{m_{Fe}}$ 2)

TABLE IVB
(Inch-pound system)

in	Hz	T	W/lb	var/lb	var/lb
0.011 ... 0.014	50	1.5	0.953	2.4	$\frac{8.2\,A_{Fe}}{m_{Fe}}$ 3)
0.011 ... 0.014	60	1.5	1.1	2.47	$\frac{9.8\,A_{Fe}}{m_{Fe}}$ 3)
0.004	400	1.3	9.07	11.34	$\frac{49.0\,A_{Fe}}{m_{Fe}}$ 3)

1) These values are based on a nominal gap length of 45 µm (0.0018 in). Other values for Q_{Gs} are to be subject to special agreement between user and manufacturer.

2) In Table IVA, the effective cross-sectional area A_{Fe} is in square centimetres and the mass m_{Fe} is in kilogrammes. The relevant values are given in Table IX, pages 32 and 33.

3) A_{Fe} in square inches; m_{Fe} in pounds.

8. Details of standard sizes

8.1 *C-core loops*

The maximum permissible values of power loss and total apparent power are given in Section Four, Table X, page 34. The mass m_{Fe}, the effective minimum cross-sectional area A_{Fe} and the mean flux path length l_{Fl} are given in Section Four, Table VIII, page 27, and have been calculated using the following formulae:

$$m_{Fe} = A_{Fe} \cdot l_{Fl} \cdot \rho$$

A_{Fe}, expressed in square centimetres or square inches respectively, is calculated from the minimum dimensions D_{min} and E_{min}, according to Table VI, page 19, and the space factor α, the values of which are given in Table V:

$$A_{Fe} = D_{min} \cdot E_{min} \cdot \alpha$$

TABLE V
Space factor

Nominal strip thickness		α
(mm)	in	
0.28 ... 0.35	0.011 ... 0.014	0.95
0.10	0.004	0.92
0.05 0.025	0.002 0.001	0.88 0.82

l_{Fl}, expressed in centimetres or inches respectively, is the mean flux path length, calculated from the dimensions given in Table VI, page 19:

$$l_{Fl} = A_{max} + B_{max} + F_{min} + G_{min} - 1.72\left(R + \frac{E_{max}}{2}\right)$$

$\rho = 7.65$ g/cm³ (0.277 lb/in³) for cold-reduced silicon-iron alloy

8.2 *E-core loops*

The maximum permissible values of power loss and total apparent power are given in Section Four, Table XI, page 38.

The mass m_{Fe} and effective minimum cross-sectional area A_{Fe} are given in Section Four, Table IX, page 32, and have been calculated using the following formulae:

$$m_{Fe} = \rho \cdot A_{Fe}\,[A_{max} + B_{max} + 2\,F_{min} + 2\,G_{min} - 0.074\,E_{max} - 2.58\,R]$$

A_{Fe}, expressed in square centimetres or square inches respectively, is calculated from the minimum dimensions D_{min} and E_{min}, according to Table VII, page 24, and the space factor α, according to Table V (see Sub-clause 8.1):

$$A_{Fe} = D_{min} \cdot E_{min} \cdot \alpha$$

The other dimensions, expressed in centimetres or inches respectively, used in the formula are also given in Table VII:

$\rho = 7.65$ g/cm³ (0.277 lb/in³) for cold-reduced silicon-iron alloy

Note. - For E-core loops, due to their construction and method of operation, it is not possible to give a mean flux path length as for C-core loops.

SECTION THREE - TESTS

9. General considerations

9.1 *Type test and acceptance tests*

9.1.1 *Type*

A type comprises products having similar design features, manufactured by the same techniques and falling within the manufacturer's usual range of ratings for these products.

Notes 1. - Ratings cover the combination of:
a) electrical ratings;
b) dimensions;
c) environmental conditions.

2. - The limits of the range of ratings shall be agreed between user and manufacturer.

9.1.2 *Type test*

The type test of a product is the complete series of tests given in Appendix A, to be carried out on a number of specimens representative of the type, with the object of determining whether a particular manufacturer's product can be considered to meet the specification.

9.1.3 *Acceptance tests*

Acceptance tests are tests carried out to determine the acceptability of a consignment on the basis of an agreement between customer and manufacturer. The agreement shall cover:

a) the sample size;
b) the selection of tests;
c) the extent to which the test specimens shall conform to the requirements for the selected tests of the specification.

Note. – In cases of divergent test results, the IEC standard test methods shall be used for acceptance tests.

9.1.4 *Factory tests*

Factory tests are those tests carried out by the manufacturer to verify that his products meet the specification.

9.1.5 *Application of tests*

The appropriate number of specimens to be tested in any particular case depends upon the purpose of the testing; it shall be agreed upon between user and manufacturer. The minimum number of specimens to be subjected to any single test shall be not less than five, unless otherwise agreed by the user and the manufacturer.

This standard does not specify the number of permissible failures; this is considered to be the prerogative of the authority giving type approval.

Note. – Part of a full range, or individual items, given in this standard, may be submitted to the type tests in order to obtain a limited type approval.

9.2 *Standard testing conditions*

Unless otherwise specified, all tests shall be carried out at the standard atmospheric conditions for testing as recommended by IEC Publication 68-1: Basic Environmental Testing Procedures, Part 1: General, viz:

- Temperature +15 °C to +35 °C.
- Relative humidity 45% to 75%.
- Air pressure 860 mbar to 1 060 mbar.

10. Visual examination

The visual examination comprises a check on the marking and on the general appearance and condition. The marking shall be in accordance with Sub-clause 4.5 and the general appearance and condition with Sub-clause 4.3.

11. Dimensions

11.1 *General*

The user of any type of strip-wound cut core is always concerned about three of the mechanical aspects of the core:

a) that the core will enter its associated coil former or bobbin;
b) that the cross-sectional area is not less than its specified value;
c) that the maximum overall dimensions are not exceeded.

Small deviations from rectangularity of the windows and outer profiles are acceptable provided that the conditions *a)*, *b)* and *c)* given above are met.

Sub-clauses 11.2 to 11.4 give possible methods of verifying the above conditions.

11.2 *Cross-sectional area*

The dimensions D and E are checked with a caliper gauge as near as possible to each cut face of the core halves. All limbs of each core half shall be so checked.

These dimensions shall lie within the minimum and maximum values given in Tables VI and VII, pages 19 and 24. When considering dimension D, the lack of relative planicity (tilt) should be borne in mind. This tilt shall not exceed $B/150$ (see Figure 1, page 14).

11.3 *Maximum overall dimensions*

The maximum overall dimensions are to be verified with the aid of a box-type gauge with the following inner dimensions according to Tables VI or VII:

Width $= A_{max}$
Length $= B_{max}$

The two parts of a complete core loop correctly placed together according to the marking, mentioned in Sub-clause 4.5, shall easily enter the gauge.

11.4 *Minimum window dimensions - Maximum depth and build-up*

With the core inserted into a tube gauge having the dimensions shown in Figure 2, page 15 , the core halves shall meet correctly. Each limb of the core loop shall be so checked.

Note. - It is strongly recommended that the design of the gauge, shown in Figure 2 for simplicity as a tube gauge, should be such that when a core is inserted into it, the correct closure of all gaps may be visually confirmed.

12. Environmental tests

12.1 *Cold*

12.1.1 *Initial examination*

The general condition and marking of the sample are to be examined visually and shall be in accordance with Sub-clauses 4.3 and 4.5.

12.1.2 *Conditioning*

The core shall be correctly assembled and banded together. The test shall be carried out in accordance with Test Aa, Cold, of IEC Publication 68-2-1, at the lower value of the temperature range selected from Table II, page 4. The samples shall remain at the test temperature until thermal stability is reached but not less than 2 h.

12.2 *Hot oil*

12.2.1 *Initial examination*

The general condition and marking of the sample are to be examined visually and shall be in accordance with Sub-clauses 4.3 and 4.5.

12.2.2 *Conditioning*

The core shall be correctly assembled and banded together. It shall be immersed in silicone transformer oil at ambient temperature. The temperature of the oil is then raised within not less than ½ h and not more than 1 h to the upper value of the appropriate range selected from Table II, page 4, $\pm 2\,°C$. The core shall be kept in the oil at this temperature for at least 24 h. After this period, the core shall be removed to cool off at normal atmospheric conditions.

Note. – Essential characteristics of the oil:
- Operating temperature $\geq 160\,°C$;
- Chemical stability, absence of acid;
- Absence of volatile or toxic components.

12.3 *Temperature cycling*

12.3.1 *Initial examination*

The general condition and marking of the sample are to be examined visually and shall be in accordance with Sub-clauses 4.3 and 4.5.

12.3.2 *Conditioning*

The core shall be correctly assembled and banded together. The test shall be carried out in accordance with Test Na, Rapid change of temperature, two chamber method, of IEC Publication 68-2-14. The specimens shall be subjected to five test cycles at the following conditions and durations:

30 min at the lower temperature of the range selected from Table II;
30 min at the higher temperature of the range selected from Table II.

The change-over time shall be not less than 2 min and not more than 3 min.

12.3.3 *Recovery*

After conditioning, the samples shall be brought to standard atmospheric conditions before testing.

12.4 *Rigidity*

12.4.1 *Initial examination*

The general condition and marking of the sample are to be examined visually and shall be in accordance with Sub-clauses 4.3 and 4.5.

12.4.2 *Conditioning*

Version a

A strip-wound cut core shall be banded together by an appropriate steel band, applied centrally. A force is applied to the band so that the pressure related to the cut surface ($D_{min} \cdot E_{min}$) is 200 N/cm² (290 lb/in²).

After removal of the band, the two parts of the core are placed between two flat steel plates applied to the sides containing the edges. The core is then subjected to a pressure of 7 N/cm² (10 lb/in²), related to the surface given by $l_{Fl} \cdot E_{min}$ for C-core loops and by $\frac{m_{Fe}}{\rho \cdot A_{Fe}} \cdot E_{min}$ for E-core loops.

Version b (applicable to C-core loops only)

The force is applied on the two parts of the core by an apparatus with flexible surfaces, e.g. flexible bands (see Figure 3, page 16)

Note. - It must be emphasized that a core having passed the tests of Sub-clauses 12.1, 12.2 and 12.3 can be considered as having sufficient rigidity. Cores should only be submitted to the test of Sub-clause 12.4 when special applications require the direct testing of rigidity.

12.5 *Final verification*

After all the selected climatic and mechanical tests, the cores shall be examined and their general appearance and condition shall remain in accordance with Sub-clause 4.3.

It shall be verified that the cores meet the specified dimensional and electrical requirements. The requirement that the markings shall remain easily legible after the climatic and mechanical tests shall be subject to agreement between user and manufacturer.

13. Electrical tests

13.1 *C-core loops*

13.1.1 *Test conditions*

The gap surfaces of the cores under test shall be clean and free from dust, burrs, protective finish, etc.

The measurements shall be carried out in the measuring circuit according to Figure 4a or 4b, page 17, with the flux density (induction) and at the frequency specified in Table III, page 5.

The number of turns N_1 and N_2 of the windings shall be adapted to the instruments used. The voltage winding N_2 shall be the inner winding and shall be as close as possible to the core. The resistance of both windings shall be as low as possible.

The voltage U_2 shall be adjusted to the appropriate value calculated from the r.m.s. voltage per turn U_2^+ in accordance with Sub-clauses 13.1.2 and 13.1.3. For the preferred core sizes, U_2^+ is given in Table X, page 34.

The deviation of the form factor of U_2 shall not exceed 6%. This can be checked by simultaneous readings of voltmeters V_1 (measuring average voltage) and V_2 (measuring r.m.s. voltage).

Note. - For non-preferred sizes, U_2^+ can be calculated from:

$$U_2^+ = 2\pi f \cdot A_{Fe} \cdot \frac{\hat{B}}{\sqrt{2}}$$

$\hat{B}$ being the appropriate value according to Table III.

13.1.2 *Measurement of total power loss*

For the measuring circuit according to Figure 4a, the voltage setting U_2 is calculated from:

$$U_2 = U_2^+ \cdot \frac{N_2}{1 + R_2\left(\frac{1}{R_V} + \frac{1}{R_W}\right)}$$

where:

R_2 = d.c. resistance of winding N_2
R_V = resistance of voltmeter V_2
R_W = resistance of voltage circuit of wattmeter

The wattmeter W is read when voltmeter V_1 is disconnected. The total power loss P_L is calculated from the measured power P_m as follows:

$$P_L = \left[1 + R_2\left(\frac{1}{R_v} + \frac{1}{R_w}\right)\right] \left[\frac{N_1}{N_2} \cdot P_m - U_2^2\left(\frac{1}{R_v} + \frac{1}{R_w}\right)\right]$$

When the voltage circuits of the instruments show high input impedance and the actual values of voltage and power can be read directly (such as for instruments with incorporated amplifiers), these equations reduce to:

$$U_2 = U_2^+ \cdot N_2 \qquad P_L = \frac{N_1}{N_2} \cdot P_m$$

Note. - When no direct reading is possible, e.g. when external amplifiers are used (Figure 4b, page 17), the gain of the amplifiers has to be taken into account.

13.1.3 *Measurement of total apparent power*

In the measuring circuit according to Figure 4a, the wattmeter is disconnected. The voltage is calculated from:

$$U_2 = U_2^+ \cdot N_2 \frac{R_v}{R_v + R_2}$$

The primary current I_1 and the secondary voltage U_2 are simultaneously measured with A and V_2 respectively, voltmeter V_1 being disconnected. The total apparent power is derived from:

$$S = \frac{N_1}{N_2} \cdot \frac{R_v + R_2}{R_v} \cdot U_2 I_1$$

When the voltmeter shows high input impedance and the actual values of voltage and current can be read directly (such as for instruments with incorporated amplifiers), these equations reduce to:

$$U_2 = U_2^+ \cdot N_2 \qquad S = \frac{N_1}{N_2} \cdot U_2 I_1$$

Note. - When no direct reading is possible, e.g. when external amplifiers are used (Figure 4b), the gain of the amplifiers has to be taken into account.

13.2 *E-core loops*

13.2.1 *Test conditions*

The precautions stipulated in Sub-clause 13.1.1 for C-core loops also apply to E-core loops. The measurements shall be carried out in accordance with Figure 5, page 18, at the flux density and frequency specified in Table IV, page 6.

The voltage per turn U_2^+, used to determine the voltage U_2 to be applied during the measurement, is given in Table XI, page 38, for the preferred sizes of core.

The three-phase, three-wire or four-wire primary supply system shall be symmetrical.

13.2.2 *Measurement of power loss*

The measurement is made with the three-wattmeter method (Figure 5). The induced voltage is measured by a voltmeter connected to the terminals of the secondary winding of the middle limb of the core. The total power loss is the sum of the losses of all the phases.

13.2.3 *Measurement of apparent power*

The method for C-core loops given in Sub-clause 13.1.3 may be applied to E-cores with the exception that the currents of each phase must be measured. The total apparent power is the sum of the apparent power dissipated in the three phases.

SECTION FOUR - DATA FOR PREFERRED CORE SIZES

14. Dimensional lists

14.1 *C-core loops*

The preferred sizes of C-core loops are divided into five series, as follows:

Series P consists of very small cores of U.S.A. origin.

Series Q is the HWR series in a U.K. specification. It is also adopted by other countries in their standards (e.g. German standard DIN 41 309, series SG, French standard CCTU 06-01 B).

Series M, R and U are the SM, SE and SU series, respectively, of the German standard DIN 41 309:

Series M contains cores whose sizes are intermediate between those of Series P and Q.

Series R contains cores larger than those in Series Q.

Series U extends the preferred sizes to even larger values.

The dimensions of C-cores are given in Table VI, page 19.

14.2 *E-core loops*

The preferred sizes of E-core loops are divided into three series, as follows:

Series 3 P consists of small cores of French and British origin.

Series 3 Q consists of medium size cores of British origin.

Series 3 U consists of large cores of German origin (DIN 41 309, series S 3U).

The dimensions of E-core loops are given in Table VII, page 24.

15. Electrical properties

The electrical properties are specified in Tables X and XI, pages 34 and 38.

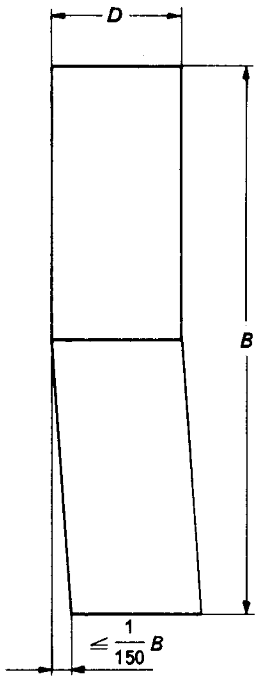
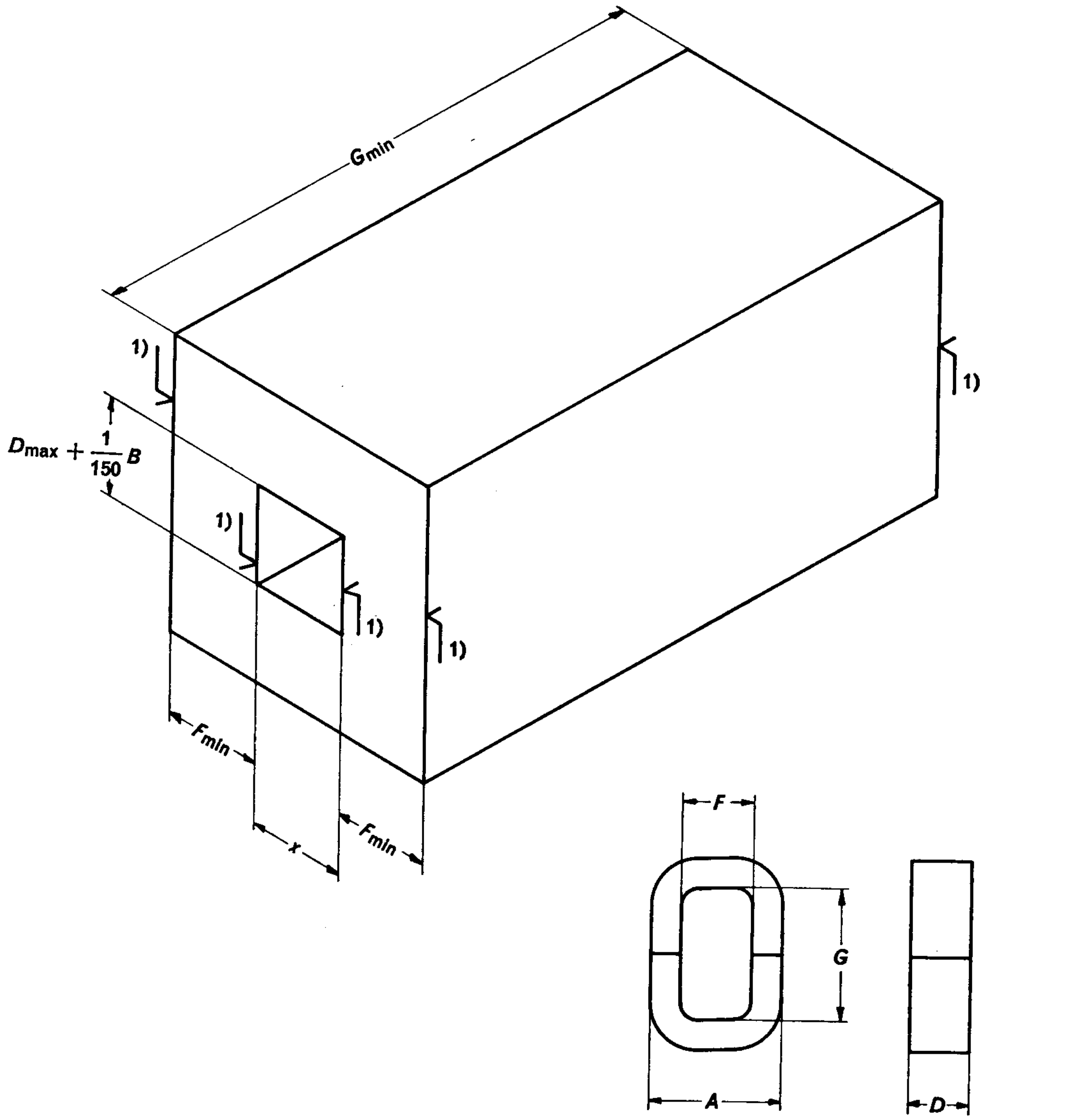


FIG. 1. – Tilt.



$x = \frac{1}{2} (A_{max} - F_{min})$ **for C-core loops**

$\frac{1}{3} (A_{max} - 2F_{min})$ **for E-core loops**

1) All these edges to be radiused or chamfered to clear corresponding inner radii specified for the core.

FIG. 2. - **Tube gauge.**

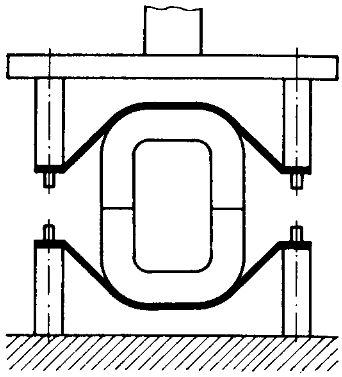


FIG. 3. – Rigidity test.

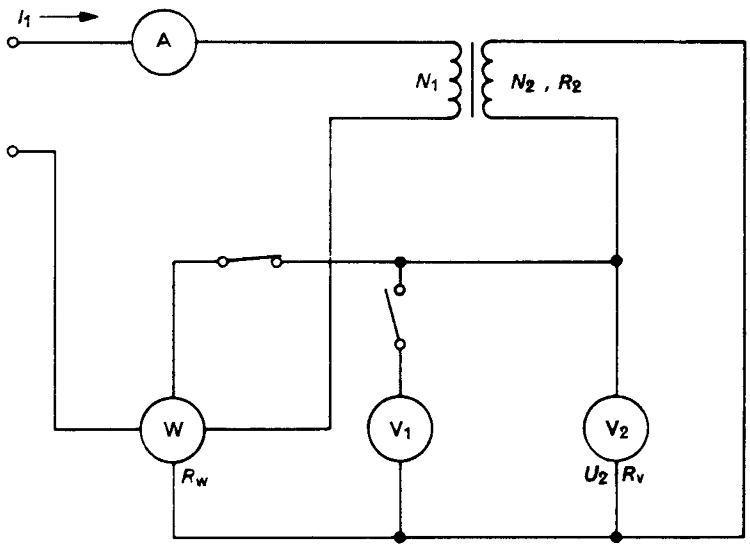


FIG. 4a. - Electrical tests of C-cores, direct method.

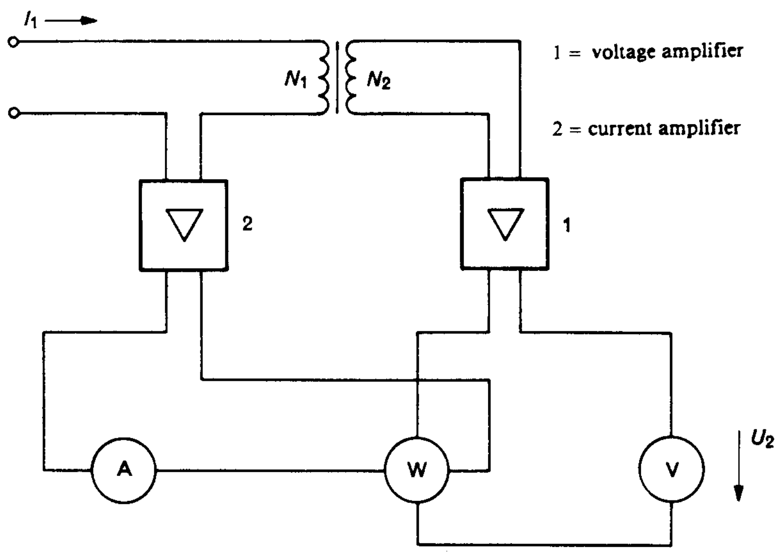
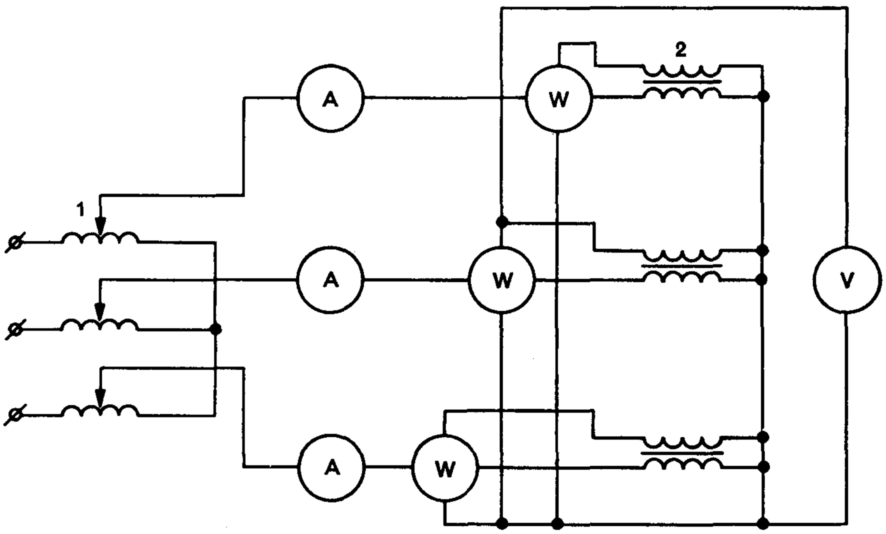


FIG. 4b. - With amplifiers.



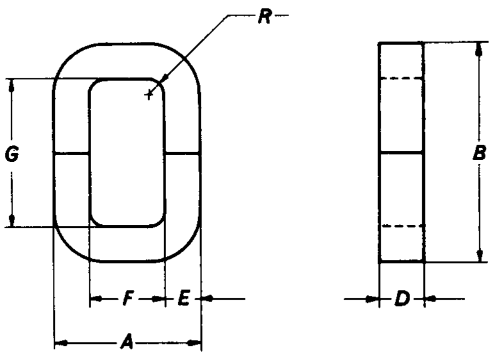
1 = transformer

2 = object to be measured

FIG. 5. - Three-wattmeter method.

TABLE VI

Dimensional lists of C-core loops



Origin } USA | Series P | Original unit inch

Type	A_{max}		B_{max}		D_{min}		D_{max}		E_{min}		E_{max}		F_{min}		G_{min}		R_{max}	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
P 1.1	7,1	0,281	14,3	0,563	3,2	0,125	4,0	0,156	1,2	0,047	2,0	0,078	2,8	0,109	9,1	0,359	0,8	0,03
2.1	10,3	0,406	17,5	0,688	3,2	0,125	4,0	0,156	2,8	0,109	3,6	0,141	2,8	0,109	9,1	0,359	0,8	0,03
3.1	11,1	0,438	17,5	0,688	6,4	0,250	7,1	0,281	2,8	0,109	3,6	0,141	3,6	0,141	9,1	0,359	0,8	0,03
P 4.1	11,9	0,469	17,5	0,688	3,2	0,125	4,0	0,156	2,8	0,109	3,6	0,141	4,4	0,172	9,1	0,359	0,8	0,03
4.2					6,4	0,250	7,1	0,281										
P 5.1	13,5	0,531	20,6	0,813	6,4	0,250	7,1	0,281	2,8	0,109	3,6	0,141	6,0	0,234	12,3	0,484	0,8	0,03

Available with 0.025 mm and 0.05 mm (0.001 in and 0.002 in) strips only.

TABLE VI *(continued)*

Origin } UK Standard DEF 5193, HWR   Series Q   Original unit inch

Type	A_{max} mm	A_{max} in	B_{max} mm	B_{max} in	D_{min} mm	D_{min} in	D_{max} mm	D_{max} in	E_{min} mm	E_{min} in	E_{max} mm	E_{max} in	F_{min} mm	F_{min} in	G_{min} mm	G_{min} in	R_{max} mm	R_{max} in
Q 1.1*	21,0	0,828	29,4	1,156	6,4	0,250	7,2	0,28	6,4	0,250	7,2	0,28	6,4	0,250	14,3	0,563	1,0	0,04
2.1*	25,8	1,016	35,7	1,406	7,9	0,313	8,7	0,34	7,9	0,313	8,7	0,34	7,9	0,312	17,5	0,688		
3.1	30,6	1,203	43,7	1,719	9,5	0,375	10,3	0,41	9,5	0,375	10,3	0,41	9,5	0,375	22,2	0,875		
4.1	32,1	1,266	50,0	1,969	9,5	0,375	10,3	0,41	9,5	0,375	10,3	0,41	11.1	0,438	28,6	1,125		
Q 5.1	30,6	1,203	56,4	2,219	12,7	0,500	13,5	0,53	7,9	0,313	8,7	0,34	12,7	0,500	38,1	1,500	1,5	0,06
5.2					19,0	0,750	19,8	0,78										
5.3					25,4	1,000	26,2	1,03										
5.4					38,1	1,500	38,9	1,53										
Q 6.1	36,9	1,453	73,0	2,875	12,7	0,500	13,5	0,53	9,5	0,375	10,3	0,41	15,9	0,625	50,8	2,000		
6.2					19,0	0,750	19,8	0,78										
6.3					25,4	1,000	26,2	1,03										
6.4					31,7	1,250	32,5	1,28										
Q 7.1	40,1	1,578	79,4	3,125	19,0	0,750	19,8	0,78	9,5	0,375	10,3	0,41	19,0	0,750	57,2	2,250	3,0	0,12
7.2					25,4	1,000	26,2	1,03										
7.3					31,7	1,250	32,5	1,28										
7.4					38,1	1,500	38,9	1,53										
Q 8.1	49,6	1,953	92,1	3,625	22,2	0,875	23,0	0,91	12,7	0,500	13,5	0,53	22,2	0,875	63,5	2,500		
8.2					28,6	1,125	29,4	1,16										
8.3					38,1	1,500	38,9	1,53										
8.4					50,8	2,000	51,6	2,03										
Q 9.1	62,3	2,453	111,1	4,375	19,0	0,750	19,8	0,78	15,9	0,625	16,7	0,66	28,6	1,125	76,2	3,000		
9.2					28,6	1,125	29,4	1,16										
9.3					38,1	1,500	38,9	1,53										
9.4					50,8	2,000	51,6	2,03										
Q 10.1	75,0	2,953	130,2	5,125	25,4	1,000	26,2	1,03	19,0	0,750	19,8	0,78	34,9	1,375	88,9	3,500		
10.2					38,1	1,500	38,9	1,53										
10.3					50,8	2,000	51,6	2,03										
10.4					69,8	2,750	71,4	2,81										
Q 11.1	97,2	3,828	169,9	6,687	31,7	1,250	32,5	1,28	25,4	1,000	26,2	1,03	44,4	1,750	114,3	4,500		
11.2					50,8	2,000	51,6	2,03										

* Available with 0.10 mm (0.004 in) strips (and smaller) only.

TABLE VI *(continued)*

Origin } German Standard DIN 41 309 Series R — Series SE

Original unit mm

Type	A_{max} mm	A_{max} in	B_{max} mm	B_{max} in	D_{min} mm	D_{min} in	D_{max} mm	D_{max} in	E_{min} mm	E_{min} in	E_{max} mm	E_{max} in	F_{min} mm	F_{min} in	G_{min} mm	G_{min} in	R_{max} mm	R_{max} in
R 1.1	65,3	2,571	108,8	4,283	36,0	1,417	37,2	1,465	16,5	0,650	17,4	0,685	30,0	1,181	73	2,874	2,0	0,08
1.2					46,0	1,811	47,2	1,858										
R 2.1	75,2	2,961	123,8	4,874	40,0	1,575	41,2	1,622	18,9	0,744	19,8	0,780	35,0	1,378	83	3,268	2,0	0,08
2.2					50,0	1,969	51,2	2,016										
2.3					60,0	2,362	61,2	2,409										
R 3.1	85,0	3,346	145,8	5,740	54,5	2,146	56,0	2,205	21,1	0,831	22,1	0,870	40,0	1,575	100	3,937	3,0	0,12
3.2					64,5	2,539	66,0	2,598										
3.3					74,5	2,933	76,0	2,992										
R 4.1	98,2	3,866	186,8	7,354	55,5	2,185	57,0	2,244	26,2	1,032	27,3	1,075	42,5	1,673	130	5,118	3,0	0,12
4.2					68,5	2,697	70,0	2,756										
4.3					83,5	3,287	85,0	3,346										
R 5.1	116,1	4,571	216,0	8,504	61,5	2,421	63,0	2,480	30,8	1,213	32,1	1,264	50,5	1,988	149	5,866	3,0	0,12
5.2					77,5	3,051	79,0	3,110										
5.3					96,5	3,800	98,0	3,858										

TABLE VI *(continued)*

Origin } German Standard DIN 41 309 Series U Original unit mm

Series SU

Type	A_{max} mm	A_{max} in	B_{max} mm	B_{max} in	D_{min} mm	D_{min} in	D_{max} mm	D_{max} in	E_{min} mm	E_{min} in	E_{max} mm	E_{max} in	F_{min} mm	F_{min} in	G_{min} mm	G_{min} in	R_{max} mm	R_{max} in
U 1.1 1.2	30,0	1,181	52,7	2,075	9,5 15,5	0,374 0,610	10,1 16,1	0,398 0,634	9,1	0,358	9,9	0,390	10	0,394	32,5	1,280	1,5	0,06
U 2.1 2.2	39,1	1,539	67,9	2,673	12,5 19,5	0,492 0,768	13,4 20,4	0,528 0,803	12,1	0,476	12,9	0,508	13	0,512	41,5	1,634	1,5	0,06
U 3.1 3.2	48,0	1,890	82,9	3,264	15,5 24,5	0,610 0,965	16,5 25,5	0,650 1,004	14,9	0,587	15,8	0,622	16	0,630	50,5	1,988	1,5	0,06
U 4.1 4.2	60,1	2,366	103,6	4,079	19,5 29,5	0,768 1,161	20,6 30,6	0,811 1,205	18,9	0,744	19,8	0,780	20	0,787	63,0	2,480	2,0	0,08
U 5.1 5.2	75,0	2,953	128,6	5,063	25,0 40,0	0,984 1,575	26,1 41,1	1,028 1,618	23,7	0,933	24,7	0,972	25	0,984	78,0	3,071	2,0	0,08
U 6.1 6.2	90,0	3,543	155,8	6,134	29,5 49,5	1,161 1,949	30,9 50,9	1,217 2,004	28,5	1,122	29,6	1,165	30	1,181	95,0	3,740	3,0	0,12
U 7.1 7.2	102,4	4,031	175,4	6,906	34,0 55,0	1,339 2,165	35,4 56,4	1,394 2,220	32,5	1,280	33,7	1,327	34	1,339	106,0	4,173	3,0	0,12
U 8.1 8.2	114,4	4,504	195,6	7,701	37,5 61,5	1,476 2,421	39,2 63,2	1,543 2,488	36,3	1,429	37,6	1,480	38	1,496	118,0	4,646	3,0	0,12
U 9.1 9.2	132,1	5,201	225,4	8,874	43,5 69,5	1,713 2,736	45,2 71,2	1,780 2,803	42,0	1,654	43,4	1,709	44	1,732	136,0	5,354	3,0	0,12
U 10.1 10.2	150,2	5,913	255,6	10,063	49,5 74,5	1,949 2,933	51,2 76,2	2,016 3,000	47,9	1,886	49,4	1,945	50	1,969	154,0	6,063	3,0	0,12
U 11.1 11.2	168,3	6,626	286,0	11,260	55,0 89,0	2,165 3,504	57,0 91,0	2,244 3,583	53,7	2,114	55,3	2,177	56	2,205	172,0	6,772	3,0	0,12
U 12.1 12.2 12.3	181,3	7,138	307,2	12,094	60,0 75,0 90,0	2,362 2,953 3,543	62,0 77,0 92,0	2,441 3,031 3,622	57,9	2,280	59,7	2,350	60	2,362	184,0	7,244	3,0	0,12
U 13.1 13.2 13.3	211,2	8,315	357,2	14,063	69,5 99,5 129,5	2,736 3,917 5,098	71,7 101,7 131,7	2,823 4,004 5,185	67,6	2,661	69,6	2,740	70	2,756	214,0	8,425	3,0	0,12
U 14.1 14.2 14.3	242,2	9,535	406,2	15,992	79,5 106,5 136,5	3,130 4,193 5,374	81,7 108,7 138,7	3,217 4,280 5,461	77,6	3,055	79,6	3,134	80	3,150	243,0	9,567	3,0	0,12

TABLE VI *(continued)*

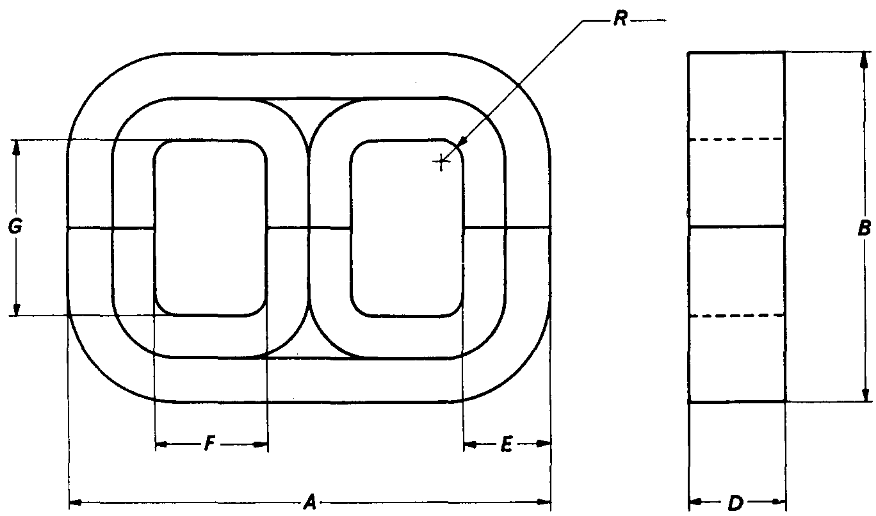
Origin } German Standard DIN 41 309 Series M Original unit mm

Series SM

Type	A_{max} mm	A_{max} in	B_{max} mm	B_{max} in	D_{min} mm	D_{min} in	D_{max} mm	D_{max} in	E_{min} mm	E_{min} in	E_{max} mm	E_{max} in	F_{min} mm	F_{min} in	G_{min} mm	G_{min} in	R_{max} mm	R_{max} in
M 1.1	14,3	0,563	28,6	1,126	6,5	0,256	7,0	0,276	3,0	0,118	3,5	0,138	7,0	0,276	21,0	0,827	1,0	0,039
1.2					10,5	0,413	11,0	0,433										
M 2.1	21,8	0,858	43,6	1,717	14,5	0,571	15,2	0,598	5,2	0,205	6,0	0,236	9,5	0,374	31,0	1,220	1,5	0,059
M 3.1	28,4	1,118	56,3	2,217	20,0	0,787	20,8	0,819	7,7	0,303	8,5	0,335	11,0	0,433	38,5	1,516	1,5	0,059
M 4.1	33,2	1,307	65,6	2,583	26,2	1,031	27,0	1,063	9,0	0,354	9,9	0,390	13,0	0,512	45,0	1,772	1,5	0,059
M 5.1	37,7	1,484	74,6	2,937	31,5	1,240	32,5	1,280	10,5	0,413	11,4	0,449	14,5	0,571	51,0	2,008	1,5	0,059
M 6.1	43,2	1,701	85,6	3,370	31,5	1,240	32,5	1,280	13,4	0,528	14,4	0,567	14,0	0,551	56,0	2,205	2,0	0,079
6.2					44,5	1,752	45,5	1,791										
M 7.1	51,9	2,043	103,0	4,055	34,5	1,358	35,5	1,398	15,9	0,626	16,9	0,665	17,5	0,689	68,0	2,677	2,0	0,079
7.2					51,5	2,028	52,5	2,067										

TABLE VII

Dimensional lists of E-core loops



Origin } France/UK   Series 3P   Original unit inch

Type	A_{max} mm	A_{max} in	B_{max} mm	B_{max} in	D_{min} mm	D_{min} in	D_{max} mm	D_{max} in	E_{min} mm	E_{min} in	E_{max} mm	E_{max} in	F_{min} mm	F_{min} in	G_{min} mm	G_{min} in	R_{max} mm	R_{max} in
3P 1.1					7,9	0,313	8,7	0,34										
1.2	53,0	2,087	45,0	1,771	12,7	0,500	13,5	0,53	8,0	0,315	8,8	0,346	13,0	0,512	25,0	0,984	1,6	0,063
1.3					15,9	0,625	16,7	0,66										
3P 2.1					9,5	0,375	10,3	0,41										
2.2					12,7	0,500	13,5	0,53										
2.3	65,0	2,560	56,0	2,205	15,9	0,625	16,7	0,66	10,0	0,394	10,8	0,425	16,0	0,630	32,0	1,260	1,6	0,063
2.4					19,0	0,750	19,8	0,78										
2.5					22,2	0,875	23,0	0,91										
3P 3.1					12,7	0,500	13,5	0,53										
3.2	79,5	3,130	67,5	2,657	15,9	0,625	16,7	0,66	12,7	0,500	13,5	0,531	19,0	0,750	38,1	1,500	1,6	0,063
3.3					19,0	0,750	19,8	0,78										

TABLE VII *(continued)*

Origin } UK | Series 3Q | Original unit inch

Type	A_{max} mm	A_{max} in	B_{max} mm	B_{max} in	D_{min} mm	D_{min} in	D_{max} mm	D_{max} in	E_{min} mm	E_{min} in	E_{max} mm	E_{max} in	F_{min} mm	F_{min} in	G_{min} mm	G_{min} in	R_{max} mm	R_{max} in
3Q 1	79,5	3,130	67,5	2,657	25,4	1,000	26,2	1,031	12,7	0,500	13,5	0,531	19,0	0,750	38,1	1,50	1,6	0,063
2	92,0	3,622	79,6	3,134	25,4	1,000	26,2	1,031	15,6	0,615	16,6	0,653	20,6	0,813	44,4	1,75	1,6	0,063
3	95,2	3,748	86,2	3,394	28,6	1,125	29,4	1,156	15,6	0,615	16,6	0,653	22,2	0,875	50,8	2,00	1,6	0,063
4	111,1	4,375	99,0	3,898	31,7	1,250	32,5	1,281	18,8	0,740	19,8	0,779	25,4	1,000	57,2	2,25	3,2	0,125
5	127,0	5,000	111,8	4,402	31,7	1,250	32,5	1,281	22,0	0,865	23,0	0,905	28,6	1,125	63,5	2,50	3,2	0,125
6	148,4	5,844	130,8	5,150	31,7	1,250	32,5	1,281	25,1	0,990	26,1	1,027	34,9	1,375	76,2	3,00	3,2	0,125
7	174,2	6,858	156,6	6,165	31,7	1,250	32,5	1,281	31,5	1,240	32,5	1,279	38,1	1,500	88,9	3,50	3,2	0,125
8	206,0	8,109	175,9	6,926	38,1	1,500	38,9	1,531	37,8	1,490	39,0	1,535	44,4	1,750	95,3	3,75	3,2	0,125
9	222,2	8,750	195,3	7,688	41,3	1,625	42,1	1,656	41,0	1,615	42,2	1,661	47,6	1,875	108,0	4,25	3,2	0,125
10	254,7	10,031	221,5	8,719	47,6	1,875	48,4	1,906	47,4	1,865	48,9	1,925	54,0	2,125	120,7	4,75	3,2	0,125
11	286,8	11,292	241,3	9,500	54,0	2,125	55,6	2,188	53,7	2,115	55,2	2,173	60,3	2,375	127,0	5,00	3,2	0,125
12	326,1	12,840	268,2	10,560	60,3	2,375	61,9	2,438	60,1	2,365	61,8	2,434	69,9	2,750	140,0	5,50	3,2	0,125

TABLE VII *(continued)*

Origin } German Standard DIN 41 309 — Series 3U — Original unit mm

Series S3U

Type	A_{max} mm	A_{max} in	B_{max} mm	B_{max} in	D_{min} mm	D_{min} in	D_{max} mm	D_{max} in	E_{min} mm	E_{min} in	E_{max} mm	E_{max} in	F_{min} mm	F_{min} in	G_{min} mm	G_{min} in	R_{max} mm	R_{max} in
3U 1.1 1.2	50,9	2,004	53,7	2,114	9,5 15,5	0,374 0,610	10,1 16,1	0,398 0,634	9,1	0,358	9,9	0,390	10	0,394	32,5	1,280	1,5	0,06
3U 2.1 2.2	66,0	2,598	68,9	2,713	12,5 19,5	0,492 0,768	13,4 20,4	0,528 0,803	12,1	0,476	12,9	0,508	13	0,512	41,5	1,634	1,5	0,06
3U 3.1 3.2	80,8	3,181	83,9	3,303	15,5 24,5	0,610 0,965	16,5 25,5	0,650 1,004	14,9	0,587	15,8	0,622	16	0,630	50,5	1,988	1,5	0,06
3U 4.1 4.2	100,9	3,972	104,6	4,118	19,5 29,5	0,768 1,161	20,6 30,6	0,811 1,205	18,9	0,744	19,8	0,780	20	0,787	63,0	2,480	2,0	0,08
3U 5.1 5.2	125,7	4,949	129,7	5,106	25,0 40,0	0,984 1,575	26,1 41,1	1,028 1,618	23,7	0,933	24,7	0,972	25	0,984	78,0	3,071	2,0	0,08
3U 6.1 6.2	150,6	5,929	156,8	6,173	29,5 49,5	1,161 1,949	30,9 50,9	1,217 2,004	28,5	1,122	29,6	1,165	30	1,181	95,0	3,740	3,0	0,12
3U 7.1 7.2	171,1	6,736	176,4	6,945	34,0 55,0	1,339 2,165	35,4 56,4	1,394 2,220	32,5	1,280	33,7	1,327	34	1,339	106,0	4,173	3,0	0,12
3U 8.1 8.2	191,0	7,520	196,2	7,724	37,5 61,5	1,476 2,421	39,2 63,2	1,543 2,488	36,3	1,429	37,6	1,480	38	1,496	118,0	4,646	3,0	0,12
3U 9.1 9.2	220,8	8,681	226,4	8,913	43,5 69,5	1,713 2,736	45,2 71,2	1,780 2,803	42,0	1,654	43,4	1,709	44	1,732	136,0	5,354	3,0	0,12
3U 10.1[1)] 10.2	249,6	9,827	255,6	10,063	49,5 74,5	1,949 2,933	51,2 76,2	2,016 3,000	47,9	1,886	49,4	1,945	50	1,969	154,0	6,063	3,0	0,12
3U 11.1[1)] 11.2	279,6	11,008	286,0	11,260	55,0 89,0	2,165 3,504	57,0 91,0	2,244 3,583	53,7	2,114	55,3	2,177	56	2,205	172,0	6,772	3,0	0,12
3U 12.1[1)] 12.2 12.3	301,0	11,850	307,2	12,094	60,0 75,0 90,0	2,362 2,953 3,543	62,0 77,0 92,0	2,441 3,031 3,622	57,9	2,280	59,7	2,350	60	2,362	184,0	7,244	3,0	0,12
3U 13.1[1)] 13.2 13.3	350,8	13,811	357,2	14,063	59,5 99,5 129,5	2,736 3,917 5,098	71,7 101,7 131,7	2,823 4,004 5,185	67,6	2,661	69,6	2,740	70	2,756	214,0	8,425	3,0	0,12
3U 14.1 14.2 14.3	400,8	15,780	406,2	15,992	79,5 106,5 135,5	3,130 4,193 5,374	81,7 108,7 138,7	3,217 4,280 5,461	77,6	3,055	79,6	3,134	80	3,150	243,0	9,567	3,0	0,12

[1)] Identical with 3R-Series (Type 3R 1.1 to 3R 4.3)

TABLE VIII

Mass, flux path lengths, effective cross-sectional areas, and window areas of C-core loops

The values of m_{Fe} and A_{Fe} are given for 0.05 mm (0.002 in) strips. For 0.025 mm (0.001 in) strips, m_{Fe} and A_{Fe} are obtained by multiplying the values given in the Table by 0.93:

$$\left(0,93 = \frac{\alpha_{0,025}}{\alpha_{0,05}}\right)$$

Series P

Type	m_{Fe} g	m_{Fe} lb	l_{Fl} cm	l_{Fl} in	A_{Fe} cm²	A_{Fe} in²	A_o[1] cm²	A_o[1] in²
P 1.1	0,77	0,0017	3,02	1,193	0,0334	0,00517	0,254	0,0391
1.2	2,10	0,0045	3,53	1,389	0,0778	0,0120	0,254	0,0391
1.3	4,37	0,0096	3,69	1,453	0,155	0,0240	0,326	0,0506
P 4.1	2,28	0,0050	3,85	1,515	0,0778	0,0120	0,398	0,0617
4.2	4,56	0,0100	3,85	1,515	0,155	0,0240	0,398	0,0617
P 5.1	5,70	0,0126	4,80	1,890	0,155	0,0240	0,731	0,113

Available with 0.025 mm and 0.05 mm (0.001 in and 0.002 in) strips only.

[1] A_o: window area $F_{min} \cdot G_{min}$.

TABLE VIII *(continued)*

The values of m_{Fe} and A_{Fe} are given for 0.28 mm and 0.35 mm (0.011 in and 0.014 in) strips. For 0.1 mm (0.004 inch) strips, m_{Fe} and A_{Fe} are obtained by multiplying the values given in the Table by 0.97:

$$\left(0{,}97 = \frac{\alpha_{0,1}}{\alpha_{0,28}}\right)$$

Series R

Type	m_{Fe} g	m_{Fe} lb	l_{Fl} cm	l_{Fl} in	A_{Fe} cm²	A_{Fe} in²	A_0[1] cm²	A_0[1] in²
R 1.1 1.2	1 117 1 429	2,46 3,15	25,9	10,20	5,64 7,21	0,874 1,117	21,9	3,40
R 2.1 2.2 2.3	1 631 2 040 2 454	3,60 4,50 5,40	29,7	11,69	7,18 8,98 10,80	1,113 1,392 1,674	29,0	4,50
R 3.1 3.2 3.3	2 920 3 424 3 955	6,38 7,55 8,72	34,7	13,66	10,9 12,9 14,9	1,69 2,00 2,32	40,0	6,20
R 4.1 4.2 4.3	4 529 5 579 6 826	9,98 12,30 15,06	42,9	16,89	13,8 17,0 20,8	2,14 2,64 3,22	55,3	8,56
R 5.1 5.2 5.3	6 871 8 665 10 765	15,16 19,10 23,73	49,9	19,65	18,0 22,7 28,2	2,79 3,52 4,38	75,3	11,67

[1] A_0: window area $F_{min} \cdot G_{min}$.

TABLE VIII *(continued)*

The values of m_{Fe} and A_{Fe} are given for 0.28 mm and 0.35 mm (0.011 in and 0.014 in) strips. For 0.1 mm (0.004 in) strips, m_{Fe} and A_{Fe} are obtained by multiplying the values given in the table by 0.97 ($0.97 = \alpha_{0.1}/\alpha_{0.28}$). For the strips of 0.05 mm and 0.025 mm, the factors are 0.93 and 0.86 respectively.

Series Q

Type	m_{Fe}		l_{Fl}		A_{Fe}		A_0[1]	
	g	lb	cm	in	cm²	in²	cm²	in²
Q 1.1* 1.2*	18,0 34,7	0,040 0,077	6,32 7,77	2,49 3,06	0,372 0,582	0,058 0,090	0,91 1,38	0,141 0,215
Q 3.1 4.1	63,0 73,5	0,139 0,162	9,53 11,13	3,75 4,38	0,862 0,862	0,134 0,134	2,12 3,18	0,328 0,492
Q 5.1 5.2 5.3 5.4	94 141 187 281	0,207 0,310 0,413 0,620	12,78	5,03	0,96 1,44 1,92 2,88	0,149 0,223 0,297 0,446	4,8	0,75
Q 6.1 6.2 6.3 6.4	145 218 291 363	0,320 0,480 0,641 0,801	16,54	6,51	1,15 1,72 2,30 2,87	0,178 0,267 0,356 0,445	8,1	1,25
Q 7.1 7.2 7.3 7.4	239 319 398 478	0,527 0,703 0,878 1,054	18,14	7,14	1,72 2,30 2,87 3,45	0,267 0,356 0,445 0,534	10,9	1,688
Q 8.1 8.2 8.3 8.4	432 553 739 989	0,95 1,22 1,63 2,18	21,06	8,29	2,68 3,45 4,60 6,13	0,416 0,534 0,713 0,950	14,1	2,188
Q 9.1 9.2 9.3 9.4	567 896 1 138 1 515	1,25 1,98 2,51 3,34	25,86	10,18	2,87 4,54 5,75 7,66	0,445 0,703 0,891 1,187	21,8	3,375
Q 10.1 10.2 10.3 10.4	1 079 1 619 2 163 2 966	2,38 3,57 4,77 6,54	30,68	12,08	4,60 6,90 9,23 12,65	0,71 1,07 1,43 1,96	31,0	4,81
Q 11.1 11.2	2 363 3 773	5,21 8,32	40,23	15,84	7,68 12,26	1,19 1,90	50,8	7,87

* Available with 0.10 mm (0.004 in) strips and smaller only. m_{Fe} and A_{Fe} are directly given for 0.10 mm strips.

[1] A_0: window area $F_{min} \cdot G_{min}$.

TABLE VIII *(continued)*

Series U

Type	m_{Fe} g	m_{Fe} lb	l_{Fl} cm	l_{Fl} in	A_{Fe} cm²	A_{Fe} in²	A_o cm²	A_o in²
U 1.1 1.2	71,5 117	0,158 0,258	11,4	4,49	0,82 1,34	0,127 0,208	3,25	0,504
U 2.1 2.2	163 254	0,359 0,560	14,8	5,83	1,44 2,24	0,223 0,347	5,39	0,835
U 3.1 3.2	303 480	0,668 1,06	18,1	7,13	2,19 3,47	0,339 0,538	8,08	1,25
U 4.1 4.2	605 916	1,33 2,02	22,6	8,90	3,50 5,30	0,543 0,822	12,6	1,95
U 5.1 5.2	1 210 1 940	2,67 4,28	28,2	11,1	5,63 9,01	0,873 1,40	19,5	3,02
U 6.1 6.2	2 080 3 490	4,59 7,69	34,0	13,4	7,99 13,4	1,24 2,08	28,5	4,42
U 7.1 7.2	3 080 4 990	6,79 11,0	38,4	15,1	10,5 17,0	1,63 2,64	36,0	5,58
U 8.1 8.2	4 230 6 960	9,33 15,3	42,8	16,9	12,9 21,2	2,00 3,29	44,8	6,94
U 9.1 9.2	6 590 10 490	14,5 23,1	49,5	19,5	17,4 27,7	2,70 4,29	59,8	9,27
U 10.1 10.2	9 670 14 570	21,3 32,1	56,2	22,1	22,5 33,9	3,49 5,25	77	11,9
U 11.1 11.2	13 540 21 880	29,9 48,2	63,0	24,8	28,1 45,4	4,36 7,04	96	14,9
U 12.1 12.2 12.3	17 070 21 360 25 600	37,6 47,1 56,4	67,6	26,6	33,0 41,3 49,5	5,12 6,40 7,67	110	17,1
U 13.1 13.2 13.3	26 850 38 470 50 090	59,2 84,8 110,4	78,7	31,0	44,6 63,9 83,2	6,91 9,90 12,90	150	23,2
U 14.1 14.2 14.3	40 300 54 000 69 200	88,8 119,0 152,6	89,8	35,4	58,6 78,5 101,0	9,08 12,2 15,7	194	30,1

TABLE VIII *(continued)*

Series **M**

Type	m_{Fe} g	m_{Fe} lb	l_{Fl} cm	l_{Fl} in	A_{Fe} cm²	A_{Fe} in²	A_o cm²	A_o in²
M 1.1 1.2	9,1 14,7	0,020 0,032	6,6	2,60	0,18 0,29	0,0279 0,0450	1,47	0,228
M 2.1 M 3.1 M 4.1 M 5.1	54,1 138 250 396	0,119 0,304 0,551 0,873	9,8 12,4 14,6 16,5	3,86 4,88 5,75 6,50	0,72 1,46 2,24 3,14	0,112 0,226 0,347 0,487	2,94 4,24 5,85 7,4	0,456 0,657 0,907 1,15
M 6.1 6.2	561 792	1,24 1,75	18,3	7,20	4,01 5,66	0,622 0,877	7,84	1,22
M 7.1 7.2	885 1 320	1,97 2,91	22,2	8,74	5,21 7,78	0,808 1,21	11,9	1,84

TABLE IX

Mass, cross-sectional areas and window areas of E-core loops

The values of m_{Fe} and A_{Fe} are given for 0.28 mm and 0.35 mm (0.011 in and 0.014 in) strips. For 0.1 mm (0.004 in) strips, m_{Fe} and A_{Fe} are obtained by multiplying the values given in the table by 0.97:

$$\left(0{,}97 = \frac{\alpha_{0,1}}{\alpha_{0,28}}\right)$$

Series 3P

Type	m_{Fe} kg	m_{Fe} lb	A_{Fe} cm²	A_{Fe} in²	A_0[1] cm²	A_0[1] in²
3P 1.1	0,078	0,171	0,60	0,0931		
1.2	0,125	0,276	0,96	0,150	3,25	0,504
1.3	0,156	0,344	1,21	0,187		
3P 2.1	0,146	0,323	0,90	0,140		
2.2	0,196	0,432	1,21	0,187		
2.3	0,245	0,540	1,51	0,234	5,12	0,794
2.4	0,293	0,646	1,80	0,280		
2.5	0,342	0,755	2,11	0,327		
3P 3.1	0,300	0,661	1,53	0,237		
3.2	0,376	0,828	1,92	0,297	7,25	1,125
3.3	0,450	0,992	2,29	0,356		

The values of m_{Fe} and A_{Fe} are given for 0.28 mm and 0.35 mm (0.011 in and 0.014 in) strips. For 0.1 mm (0.004 in) strips, m_{Fe} and A_{Fe} are obtained by multiplying the values given in the table by 0.97:

$$\left(0{,}97 = \frac{\alpha_{0,1}}{\alpha_{0,28}}\right)$$

Series 3Q

Type	m_{Fe} kg	m_{Fe} lb	A_{Fe} cm²	A_{Fe} in²	A_0[1] cm²	A_0[1] in²
3Q 1	0,60	1,32	3,06	0,475	7,25	1,12
2	0,85	1,88	3,77	0,584	9,18	1,42
3	1,04	2,30	4,24	0,657	11,3	1,75
4	1,59	3,50	5,67	0,879	14,5	2,25
5	2,10	4,62	6,65	1,03	18,1	2,81
6	2,86	6,30	7,60	1,18	26,6	4,13
7	4,17	9,19	9,50	1,47	33,9	5,25
8	6,80	15,0	13,7	2,12	42,4	6,56
9	8,81	19,4	16,1	2,49	51,5	7,97
10	13,3	29,4	21,4	3,32	65,1	10,10
11	18,8	41,4	27,6	4,27	76,6	11,88
12	26,4	58,1	34,4	5,34	97,6	15,13

[1] A_0: area of one window $F_{min} \cdot G_{min}$.

TABLE IX *(continued)*

The values of m_{Fe} and A_{Fe} are given for 0.28 mm and 0.35 mm (0.011 in and 0.014 in) strips. For 0.1 mm (0.004 in) strips, m_{Fe} and A_{Fe} are obtained by multiplying the values given in the table by 0.97:

$$\left(0{,}97 = \frac{\alpha_{0,1}}{\alpha_{0,28}}\right)$$

Series 3U

Type	m_{Fe} kg	m_{Fe} lb	A_{Fe} cm²	A_{Fe} in²	A_0 cm²	A_0 in²
3U 1.1 1.2	0,115 0,188	0,254 0,414	0,82 1,34	0,127 0,208	3,25	0,504
3U 2.1 2.2	0,261 0,407	0,575 0,897	1,44 2,24	0,223 0,347	5,39	0,835
3U 3.1 3.2	0,491 0,776	1,08 1,71	2,19 3,47	0,339 0,538	8,08	1,25
3U 4.1 4.2	0,98 1,47	2,15 3,24	3,50 5,30	0,543 0,822	12,6	1,95
3U 5.1 5.2	1,96 3,13	4,32 6,90	5,63 9,01	0,873 1,40	19,5	3,02
3U 6.1 6.2	3,33 5,59	7,34 12,3	7,99 13,4	1,24 2,08	28,5	4,42
3U 7.1 7.2	4,94 8,00	10,9 17,6	10,5 17,0	1,63 2,64	36,0	5,58
3U 8.1 8.2	6,79 11,14	15,0 24,6	12,9 21,2	2,00 3,29	44,8	6,94
3U 9.1 9.2	10,54 16,84	23,2 37,1	17,4 27,7	2,70 4,29	59,8	9,27
3U 10.1[1] 10.2	15,5 23,4	34,2 51,6	22,5 33,9	3,49 5,25	77	11,9
3U 11.1[1] 11:2	21,7 35,1	47,8 77,4	28,1 45,4	4,35 7,04	96	14,9
3U 12.1[1] 12.2 12.3	27,4 34,2 41,1	60,4 75,4 90,6	33,0 41,3 49,5	5,12 6,40 7,67	110	17,0
3U 13.1[1] 13.2 13.3	43,1 61,7 80,4	95,0 136,0 177,3	44,6 63,9 83,1	6,91 9,90 12,88	150	23,3
3U 14.1 14.2 14.3	64,6 86,5 111,0	142,4 190,7 244,7	58,6 78,5 101,0	9,08 12,2 15,7	194	30,1

[1] Identical with 3R-Series (Type 3R 1.1 to 3R 4.3)

TABLE X

Maximum admissible power losses and apparent power of C-core loops

Series Q[1)]

0.28 mm and 0.35 mm (0.011 in and 0.014 in) strips tested at 1.7 T; 50 Hz

Type	U_2^+ mV/ turn	P_L W	S VA
Q 3.1	32,6	0,14	1,8
4.1	32,6	0,16	1,9
Q 5.1	36,3	0,21	2,3
5.2	54,4	0,31	3,4
5.3	72,6	0,41	4,5
5.4	109,0	0,62	6,8
Q 6.1	43,5	0,32	3,1
6.2	65,0	0,48	4,7
6.3	87,0	0,64	6,3
6.4	108,0	0,80	7,9
Q 7.1	65	0,53	5,0
7.2	87	0,70	6,7
7.3	108	0,88	8,3
7.4	130	1,05	10,0
Q 8.1	101	0,95	8,6
8.2	130	1,22	11,0
8.3	174	1,63	14,7
8.4	232	2,18	19,6
Q 9.1	108	1,25	10,5
9.2	172	1,98	16,7
9.3	217	2,50	21,1
9.4	290	3,33	28,2
Q 10.1	174	2,37	19,1
10.2	260	3,56	28,7
10.3	349	4,76	38,4
10.4	478	6,53	52,7
Q 11.1	290	5,20	39,4
11.2	463	8,30	62,8

0.10 mm (0.004 in) strips tested at 1.5 T; 400 Hz

Type	U_2^+ mV/ turn	P_L W	S VA
Q 1.1	99	0,40	3,0
2.1	155	0,76	4,9
3.1	223	1,34	7,3
4.1	223	1,57	7,6
Q 5.1	249	2,01	8,8
5.2	373	3,01	13,2
5.3	497	3,99	17,5
5.4	745	6,00	26,3
Q 6.1	298	3,09	11,4
6.2	445	4,65	17,2
6.3	595	6,21	22,9
6.4	742	7,75	28,6
Q 7.1	445	5,10	17,8
7.2	595	6,81	23,8
7.3	742	8,50	29,6
7.4	893	10,2	35,6
Q 8.1	693	9,2	29,5
8.2	893	11,8	37,8
8.3	1 190	15,8	50,5
8.4	1 586	21,1	67,4
Q 9.1	742	12,1	34,7
9.2	1 174	19,2	54,9
9.3	1 488	24,3	69,5
9.4	1 982	32,3	92,6
Q 10.1	1 190	23,0	60,7
10.2	1 785	34,5	90,9
10.3	2 388	46,2	122,0
10.4	3 273	63,3	167,0
Q 11.1	1 987	50,4	119,0
11.2	3 172	80,5	189,0

[1)] See note on page 35

TABLE X *(continued)*

Series R

0.28 mm and 0.35 mm (0.011 in and 0.014 in) strips tested at 1.7 T; 50 Hz

Type	U_2^+ mV / turn	P_L W	S VA
R 1.1	213	2,46	20,7
1.2	273	3,14	26,6
R 2.1	271	3,59	29,2
2.2	339	4,49	36,5
2.3	408	5,40	43,8
R 3.1	416	6,42	50,2
3.2	488	7,53	59,0
3.3	563	8,70	68,0
R 4.1	522	10,0	74,5
4.2	643	12,3	91,8
4.3	786	15,0	112,2
R 5.1	680	15,1	109,8
5.2	858	19,1	138,8
5.3	1 066	23,7	172,0

0.10 mm (0.004 in) strips tested at 1.5 T; 400 Hz

Type	U_2^+ mV / turn	P_L W	S VA
R 1.1	1 459	23,8	68,3
1.2	1 865	30,5	87,4
R 2.1	1 857	34,8	93,3
2.2	2 323	43,5	117
2.3	2 794	52,4	140
R 3.1	2 846	62,3	156
3.2	3 337	73,1	183
3.3	3 854	84,4	211
R 4.1	3 570	96,6	222
4.2	4 398	119,1	274
4.3	5 381	145,7	335
R 5.1	4 657	147	320
5.2	5 872	185	403
5.3	7 295	230	501

Note. — The maximum admissible power losses and apparent powers of C-core loops are not given for series P because these cores are available only in 0.025 mm (0.001 in) and 0.05 mm (0.002 in) material and are used mainly in pulse application.

TABLE X *(continued)*

Maximum admissible power losses and apparent power of C-core loops

Series U

0.28 mm and 0.35 mm (0.011 in and 0.014 in) strips tested at 1.7 T; 50 Hz

Type	U_2^+ mV / turn	P_L W	S VA
U 1.1	31,0	0,16	1,82
1.2	50,6	0,26	2,98
U 2.1	54,4	0,35	3,69
2.2	84,6	0,56	5,76
U 3.1	82,7	0,67	6,34
3.2	131	1,06	10,0
U 4.1	132	1,33	11,7
4.2	200	2,02	17,8
U 5.1	213	2,67	22,1
5.2	340	4,28	35,3
U 6.1	302	4,57	36,0
6.2	506	7,67	60,3
U 7.1	397	6,78	51,9
7.2	642	11,0	84,0
U 8.1	487	9,31	69,7
8.2	601	15,3	114
U 9.1	657	14,5	105
9.2	1 050	23,1	168
U 10.1	850	21,3	152
10.2	1 230	32,1	228
U 11.1	1 060	29,8	209
11.2	1 720	48,1	337
U 12.1	1 250	37,5	260
12.2	1 500	47,0	326
12.3	1 870	56,3	390
U 13.1	1 680	59,1	402
13.2	2 410	84,6	576
13.3	3 120	110,0	749
U 14.1	2 210	88,7	594
14.2	2 970	119	796
14.3	3 820	152	1 020

0.10 mm (0.004 in) strips tested at 1.5 T; 400 Hz

Type	U_2^+ mV / turn	P_L W	S VA
U 1.1	212	1,54	7,27
1.2	347	2,50	11,9
U 2.1	372	3,46	13,8
2.2	579	5,40	21,5
U 3.1	566	6,47	22,6
3.2	897	10,3	35,9
U 4.1	905	13,0	39,9
4.2	1 370	19,6	50,3
U 5.1	1 450	25,8	70,8
5.2	2 330	41,4	114,0
U 6.1	2 070	44,4	112
6.2	3 470	74,5	133
U 7.1	2 720	65,7	158
7.2	4 400	106	255
U 8.1	3 340	90,3	208
8.2	5 480	149	343
U 9.1	4 500	141	308
9.2	7 160	224	490
U 10.1	5 820	206	434
10.2	8 770	311	654
U 11.1	7 270	288	587
11.2	11 700	467	950
U 12.1	8 530	364	727
12.2	10 700	456	910
12.3	12 800	546	1 090
U 13.1	11 500	573	1 100
13.2	16 500	821	1 580
13.3	21 500	1 069	2 060
U 14.1	15 200	860	1 610
14.2	20 300	1 150	2 160
14.3	26 100	1 480	2 770

TABLE X *(continued)*

Maximum admissible power losses and apparent power of C-core loops

Series M

0.28 mm and 0.35 mm (0.011 in and 0.014 in) strips tested at 1.7 T; 50 Hz

Type	U_2^+ mV / turn	P_L W	S VA
M 1.1 1.2	6,8 11,0	0,020 0,032	0,32 0,51
M 2.1	27,2	0,12	1,49
M 3.1	55,1	0,30	3,38
M 4.1	85,0	0,55	5,70
M 5.1	118	0,87	8,59
M 6.1 6.2	151 213	1,23 1,74	11,7 16,5
M 7.1 7.2	196 294	1,95 2,91	17,3 25,8

0.10 mm (0.004 in) strips tested at 1.5 T; 400 Hz

Type	U_2^+ mV / turn	P_L W	S VA
M 1.1 1.2	47 75	0,19 0,31	1,41 2,28
M 2.1	186	1,15	6,14
M 3.1	378	2,94	13,2
M 4.1	579	5,34	21,4
M 5.1	812	8,45	31,3
M 6.1 6.2	1 040 1 460	12,0 16,9	41,6 58,7
M 7.1 7.2	1 350 2 010	18,9 28,2	58,7 87,5

TABLE XI

Maximum admissible power losses and apparent power of E-core loops

Series 3P

0.28 mm and 0.35 mm (0.011 in and 0.014 in) strips tested at 1.5 T; 50 Hz

Type	U_2^+ mV / turn	P_L W	S VA
3P 1.1	20,0	0,163	1,19
1.2	32,0	0,263	1,90
1.3	40,3	0,328	2,38
3P 2.1	30,0	0,307	1,94
2.2	40,3	0,412	2,61
2.3	50,3	0,515	3,26
2.4	60,0	0,615	3,90
2.5	70,3	0,720	4,55
3P 3.1	51,0	0,630	3,60
3.2	64,0	0,790	4,51
3.3	76,3	0,945	5,40

0.10 mm (0.004 in) strips tested at 1.3 T; 400 Hz

Type	U_2^+ mV / turn	P_L W	S VA
3P 1.1	134	1,50	6,45
1.2	215	2,42	10,4
1.3	271	3,02	13,0
3P 2.1	202	2,84	10,6
2.2	271	3,80	14,2
2.3	338	4,75	17,7
2.4	403	5,68	21,2
2.5	472	6,64	24,8
3P 3.1	343	5,81	19,4
3.2	430	7,28	24,3
3.3	513	8,72	29,1

Series 3Q

0.28 mm and 0.35 mm (0.011 in and 0.014 in) strips tested at 1.5 T; 50 Hz

Type	U_2^+ mV / turn	P_L W	S VA
3Q 1	104	1,26	7,2
2	125,5	1,79	9,5
3	141,2	2,19	11,1
4	189,0	3,33	16,1
5	221,3	4,40	20,1
6	253,0	6,00	25,5
7	316,3	8,75	35,3
8	456,1	14,3	55,4
9	536	18,5	69,6
10	713	28,0	102
11	918	39,4	141
12	1 146	55,4	192

0.10 mm (0.004 in) strips tested at 1.3 T; 400 Hz

Type	U_2^+ mV / turn	P_L W	S VA
3Q 1	685	11,7	39,0
2	844	16,5	51,2
3	950	20,2	60,1
4	1 270	30,8	86,2
5	1 490	40,6	108
6	1 700	55,4	137
7	2 125	80,7	189
8	3 065	132	297
9	3 600	171	367
10	4 790	258	546
11	6 180	364	755
12	7 700	511	1 030

TABLE XI *(continued)*

Maximum admissible power losses and apparent power of E-core loops

Series 3U

0.28 mm and 0.35 mm (0.011 in and 0.014 in) strips tested at 1.5 T; 50 Hz

Type	U_2^+ mV / turn	P_L W	S VA
3U 1.1	27,3	0,24	1,67
1.2	44,7	0,40	2,73
3U 2.1	47,6	0,55	3,25
2.2	74,6	0,86	5,07
3U 3.1	73,3	1,03	5,50
3.2	116	1,63	8,69
3U 4.1	117	2,05	9,85
4.2	177	3,09	14,8
3U 5.1	188	4,11	18,1
5.2	300	6,57	28.8
3U 6.1	266	6,99	28,7
6.2	447	11,7	48,1
3U 7.1	350	10,4	40,8
7.2	566	16,8	66,1
3U 8.1	430	14,3	54,3
8.2	703	23,4	89,1
3U 9.1	580	22,1	81,0
9.2	923	35,4	129,0
3U 10.1[1]	750	32,6	116
10.2	1 130	49,1	174
3U 11.1[1]	937	45,6	157
11.2	1 514	73,5	255
3U 12.1[1]	1 100	57,5	196
12.2	1 380	71,8	245
12.3	1 650	86,1	294
3U 13.1[1]	1 487	90,5	299
13.2	2 130	130	428
13.3	2 775	169	557
3U 14.1	1 950	135	438
14.2	2 615	182	587
14.3	3 350	233	753

0.10 mm (0.004 in) strips tested at 1.3 T; 400 Hz

Type	U_2^+ mV / turn	P_L W	S VA
3U 1.1	184	2,23	9,11
1.2	300	3,65	14,9
3U 2.1	320	5,04	17,6
2.2	502	9,12	29,4
3U 3.1	493	9,51	29,7
3.2	784	15,1	47,2
3U 4.1	784	19,0	54,0
4.2	1 190	28,5	79,9
3U 5.1	1 260	38,0	99,5
5.2	2 020	60,7	159
3U 6.1	1 790	64,6	154
6.2	3 000	108	258
3U 7.1	2 350	95,8	219
7.2	3 810	155	355
3U 8.1	2 890	132	292
8.2	4 750	215	477
3U 9.1	3 900	204	434
9.2	6 210	326	693
3U 10.1[1]	5 040	302	618
10.2	7 600	453	936
3U 11.1[1]	6 300	421	846
11.2	10 200	681	1 370
3U 12.1[1]	7 400	531	1 053
12.2	9 250	663	1 315
12.3	11 100	960	1 580
3U 13.1[1]	10 000	835	1 610
13.2	14 310	1 200	2 300
13.3	18 650	1 560	3 000
3U 14.1	13 100	1 250	2 360
14.2	17 600	1 680	3 160
14.3	22 500	2 150	4 050

[1] Identical with 3R-Series (Type 3R 1.1 to 3R 4.3)

APPENDIX A

LIST OF TESTS FOR STRIP-WOUND CUT CORES

Clause or Sub-clause	Test
10	Visual examination
11	Dimensions
12.1	Cold
12.2	Hot oil
12.3	Temperature cycling
12.4	Rigidity (for special applications only)
13.1.2	Power loss
13.1.3	Apparent power

APPENDIX B

COMPARATIVE LISTS OF THE REFERENCE NUMBERS UTILIZED IN DIFFERENT COUNTRIES

IEC	France	U.S.A
P		
1.1	BA 3	M 14 51
2.1	BB 3	M 14 52
3.1	BC 6	M 14 54
4.1	BD 3	M 14 53
4.2	BD 6	M 14 55
5.1	BH 6	M 3

IEC	U.K.	Germany	France
Q	DEF 5193 HWR	DIN 41309 SG	CCTU 06-01 B FA (Tabl. 2)
1.1*	3/4*	27/6*	D 06*
2.1*	4/5*	33/7*	F 08*
3.1	5/6	41/9	H 10
4.1	7/6	48/9	J 10
5.1	10/8	54/13	Q 13
5.2	10/12	54/19	Q 19
5.3	10/16	54/25	Q 25
5.4	10/24	54/38	Q 38
6.1	30/8	70/13	T 13
6.2	30/12	70/19	T 19
6.3	30/16	70/25	T 25
6.4	30/20	70/32	T 32
7.1	40/12	76/19	U 19
7.2	40/16	76/25	U 25
7.3	40/20	76/32	U 32
7.4	40/24	76/38	U 38
8.1	50/14	89/22	V 22
8.2	50/18	89/29	V 29
8.3	50/24	89/38	V 38
8.4	50/32	89/51	V 51
9.1	70/12	108/19	X 19
9.2	70/18	108/29	X 29
9.3	70/24	108/38	X 38
9.4	70/32	108/51	X 51
10.1	90/16	127/25	Z 25
10.2	90/24	127/38	Z 38
10.3	90/32	127/51	Z 51
10.4	90/44	127/70	Z 70
11.1	110/20	165/32	AD 32
11.2	110/32	165/51	AD 51

* Available with 0.1 mm and thinner strips only.

IEC	Germany
R	DIN 41 309 SE
1.1	130 a
1.2	130 b
2.1	150 a
2.2	150 b
2.3	150 c
3.1	170 a
3.2	170 b
3.3	170 c
4.1	195 a
4.2	195 b
4.3	195 c
5.1	231 a
5.2	231 b
5.3	231 c

IEC	Germany
U	DIN 41 309 SU
1.1	30 a
1.2	30 b
2.1	39 a
2.2	39 b
3.1	48 a
3.2	48 b
4.1	60 a
4.2	60 b
5.1	75 a
5.2	75 b
6.1	90 a
6.2	90 b
7.1	102 a
7.2	102 b
8.1	114 a
8.2	114 b
9.1	132 a
9.2	132 b
10.1	150 a
10.2	150 b
11.1	168 a
11.2	168 b
12.1	180 a
12.2	180 b
12.3	180 c
13.1	210 a
13.2	210 b
13.3	210 c
14.1	240 a
14.2	240 b
14.3	240 c

IEC	Germany
M	DIN 41309 SM
1.1 1.2	30 a 30 b
2.1 3.1 4.1 5.1	42 55 65 74
6.1 6.2	85 a 85 b
7.1 7.2	102 a 102 b

IEC	France
3P	NF C 93-325 FA-FL
1.1 1.2 1.3	EA 8 EA 13 EA 16
2.1 2.2 2.3 2.4 2.5	EB 10 EB 13 EB 16 EB 19 EB 22
3.1 3.2 3.3	EC 13 EC 16 EC 19

IEC	France
3Q	NF C 93-325 FA-FL
1 2 3 4 5 6 7 8 9 10 11 12	EC 25 ED 25 EF 29 EH 32 EK 32 EM 32 EP 32 ER 38 ET 41 EV 48 EX 54 EC 60

IEC	Germany
3U	DIN 41309 S 3U
1.1 1.2	30 a 30 b
2.1 2.2	39 a 39 b
3.1 3.2	48 a 48 b
4.1 4.2	60 a 60 b
5.1 5.2	75 a 75 b
6.1 6.2	90 a 90 b
7.1 7.2	102 a 102 b
8.1 8.2	114 a 114 b
9.1 9.2	132 a 132 b
10.1 10.2	150 a 150 b
11.1 11.2	168 a 168 b
12.1 12.2 12.3	180 a 180 b 180 c
13.1 13.2 13.3	210 a 210 b 210 c
14.1 14.2 14.3	240 a 240 b 240 c

APPENDIX C

STANDARD SYSTEM OF DIMENSIONAL TOLERANCES

1. General

When designing special sizes or new series of strip-wound cut cores, the dimensional tolerances should be calculated from the formulae given below and using the values given in Clause 3 of this appendix.

2. General formulae

2.1 *C-cores*

$$D_{max} = D_{min} + \Delta_D$$
$$E_{max} = E_{min} + \Delta_E$$
$$A_{max} = F_{min} + 2E_{min} + \Delta_A$$
$$B_{max} = G_{min} + 2E_{min} + \Delta_B$$

The tolerances on A and B are composed of twice the tolerance on E ($2\ \Delta_E$) and a bowing tolerance δ_A or δ_B respectively:

$$\Delta_{A,B} = 2\Delta_E + \delta_{A,B}$$

2.2 *E-cores*

$$A_{max} = 2F_{min} + 3E_{min} + \Delta_{3A}$$
$$\Delta_{3A} = 3\Delta_E + \delta_{3A}$$

For the other dimensions, the formulae for C-cores are applicable.

3. Tolerance tables

3.1 *C-cores*

Tolerances on	Dimensions mm		Dimensions in	
	Dimensional range	Δ	Dimensional range	Δ
1	2	3	4	5
D	$D \leq 30$ $30 < D \leq 70$ $70 < D$ $E > 63,5$	0,8 1,2 1,6 2,4	$D \leq 1,18$ $1,18 < D \leq 2,76$ $2,76 < D$ $E > 2,50$	0,0315 0,0472 0,063 0,096
E	$E \leq 10$[1)] $E \leq 20$ $20 < E \leq 30$ $30 < E \leq 50$	0,5[1)] 0,8 1,2 1,6	$E \leq 0,39$[1)] $E \leq 0,79$ $0,79 < E \leq 1,18$ $1,18 < E \leq 1,97$	0,0197[1)] 0,0315 0,0472 0,063
A	$B \leq 100$ $100 < B \leq 200$ $200 < B \leq 300$	$2\Delta_E + 0,5$ $2\Delta_E + 1,0$ $2\Delta_E + 1,5$	$B \leq 3,94$ $3,94 < B \leq 7,88$ $7,88 < B \leq 11,81$	$2\Delta_E + 0,0197$ $2\Delta_E + 0,039$ $2\Delta_E + 0,059$
B	$B \leq 100$ $100 < B \leq 200$ $200 < B \leq 300$	$2\Delta_E + 1,0$ $2\Delta_E + 2,5$ $2\Delta_E + 5,0$	$B \leq 3,94$ $3,94 < B \leq 7,88$ $7,88 < B \leq 11,81$	$2\Delta_E + 0,039$ $2\Delta_E + 0,098$ $2\Delta_E + 0,197$
R_{max}	$B \leq 70$ $70 < B \leq 200$ $200 < B \leq 300$	1,5 3,0 4,0	$B \leq 2,76$ $2,76 < B \leq 7,88$ $7,88 < B \leq 11,81$	0,059 0,118 0,158

Note. - In columns 2 and 4 of this table:
D equals D_{min}
E equals E_{min}
B equals $G_{min} + 2\,E_{min}$.

[1)] For cores of 0.025 mm to 0.1 mm (0.001 in to 0.004 in) strips only.

3.2 *E-core loops*

Tolerances on	Dimensions mm		Dimensions in	
	Dimensional range	Δ	Dimensional range	Δ
1	2	3	4	5
D	$D \leq 30$ $30 < D \leq 70$ $70 < D$ $E > 63{,}5$	1,0 1,5 2,0 4,0	$D \leq 1{,}18$ $1{,}18 < D \leq 2{,}76$ $2{,}76 < D$ $E > 2{,}50$	0,039 0,059 0,079 0,156
E	$E \leq 10$[1)] $E \leq 20$ $20 < E \leq 30$ $30 < E \leq 60$	0,8[1)] 1,0 1,5 2,0	$E \leq 0{,}39$[1)] $E \leq 0{,}79$ $0{,}79 < E \leq 1{,}18$ $1{,}18 < E \leq 2{,}36$	0,315[1)] 0,039 0,059 0,079
A	$B \leq 100$ $100 < B \leq 200$ $200 < B \leq 400$	$3\Delta_E + 1{,}0$ $3\Delta_E + 1{,}5$ $3\Delta_E + 2{,}0$	$B \leq 3{,}94$ $3{,}94 < B \leq 7{,}88$ $7{,}88 < B \leq 15{,}76$	$3\Delta_E + 0{,}039$ $3\Delta_E + 0{,}059$ $3\Delta_E + 0{,}079$
B	$B \leq 100$ $100 < B \leq 200$ $200 < B \leq 400$	$2\Delta_E + 2{,}0$ $2\Delta_E + 3{,}0$ $2\Delta_E + 4{,}0$	$B \leq 3{,}94$ $3{,}94 < B \leq 7{,}88$ $7{,}88 < B \leq 15{,}76$	$2\Delta_E + 0{,}079$ $2\Delta_E + 0{,}118$ $2\Delta_E + 0{,}158$

Note. – In columns 2 and 4 of this table:
D equals D_{min}
E equals E_{min}
B equals $G_{min} + 2\,E_{min}$.

1) For cores of 0.1 mm (0.004 in) strips only.

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